GEORGIA. DEPT. OF NATURAL
RESOURCES. DIVISION OF
FORESTRY

VOCATIONAL FORESTRY

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By

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Presenting a Course in Forestry for High School Students Receiving Vocational Training in Agriculture.

DEPARTMENT OF NATURAL RESOURCES
R. F. Burch, Commissioner

DIVISION OF FORESTRY
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INDEX

HOW TREES GROW

In all the world of animate things, the largest and longest lived are the trees. Consider the giant Sequoia of the Pacific coast. Some of these trees attain a height of 300 feet and are 3,000 to 4,000 years of age. While man is considered the lord of creation, his cellular achievements cannot compare with those of the trees for duration of life and for structural magnitude.

How do the trees attain their growth? The story begins in the Spring after trees have opened their buds and developed flowers. At times when trees are in full bloom and the wind is blowing, the atmosphere is hazy with tiny pollen grains released by tree flowers. The pollen is on its way to fertilize other tree flowers. Some species of trees have both male and female individuals while others bear both male and female flowers and are self-fertile. Not only is pollen carried by the wind, but by insects flying from bloom to bloom in quest of nectar for making honey. The pollen adheres to the insects' legs and becomes detached to fertilize female flowers. As a result the tree is able to produce seed.

In the seed is an embryo, also called the seed germ. The embryo cells are capable of growth—that is, they have the wonderful ability of developing cells that will reproduce the kind of tree from which the seed came. Around the embryo is a layer of starchy material, and around the outer surface of all is a hard coat.

Tree seed differ widely in size, shape, and method of development. Some are large like the walnut, hickory nut, and acorn, fully or partly enclosed with hulls. Some have round bolls or burs like chestnuts, buckeyes, chinquapins, and beech. Others like the pine, yellow poplar, magnolia, and summac, have small seed grown in cone-like structures. Still other trees develop seed in berries such as those which grow on the black cherry, haw, cedar, hackberry, dogwood, sassafras, and black gum. Exceeding the berry producers in fruity covering of their seeds are wild plums, crabapple, persimmon, mulberry, ossage orange, and others. Quite different still are the trees having their seeds in pods, among which being the black locust, honey locust, red bud, and mimosa.

The manner by which seed are dispersed from the tree is quite interesting. The pine, ash, yellow poplar, basswood, river birch, elm, and others, have seed with one or more wings, or attachments that serve as wings. With these they can volplane on the wind sometimes a half a mile from the tall parent tree. Also for wind transportation the willow and cottonwood (poplar) and others are equipped with light, cotton-like fibers to provide bouyancy.

Water also helps to move tree seed from place to place. Almost everyone has seen sycamores and red gum seed balls floating merrily down stream. Concentrated water on the soil surface in the forest will

either float or roll any kind of seed along to new sites. But heavy seed like the walnut, hickory nut, chestnut, buckeye, and acorns that fall directly to the ground have as their chief aid for distribution and also for planting, an instinct of the squirrel. This provident animal buries seed in the ground for future use, and having buried more than it needs, or having forgotten its hidden store, these heavy seed have an opportunity to come up elsewhere than under the limbs of the parent tree.

Birds are also seed carriers, especially seed of the berry type. Their fondness for the fruit leads them to eat the whole berry and deposit elsewhere the indigestible seed.

An excellent subject for student debate is, a discussion of the best method of seed distribution characteristic of various species of trees.

Pursuing the subject of how trees grow—a tree seed having made contact with the soil is in position to germinate and start a new cycle of tree life. Should the temperature be warm and rainfall sufficient, some tree seed in south Georgia may start growth in the fall, but in the upper part of the state, germination is not likely to occur until the following spring.

During the process of germination, the seed absorbs moisture and begins to swell; the seed coat breaks, and a pale shoot emerges. The downward portion develops into roots and the upward growth forms the stem and later branches and leaves.

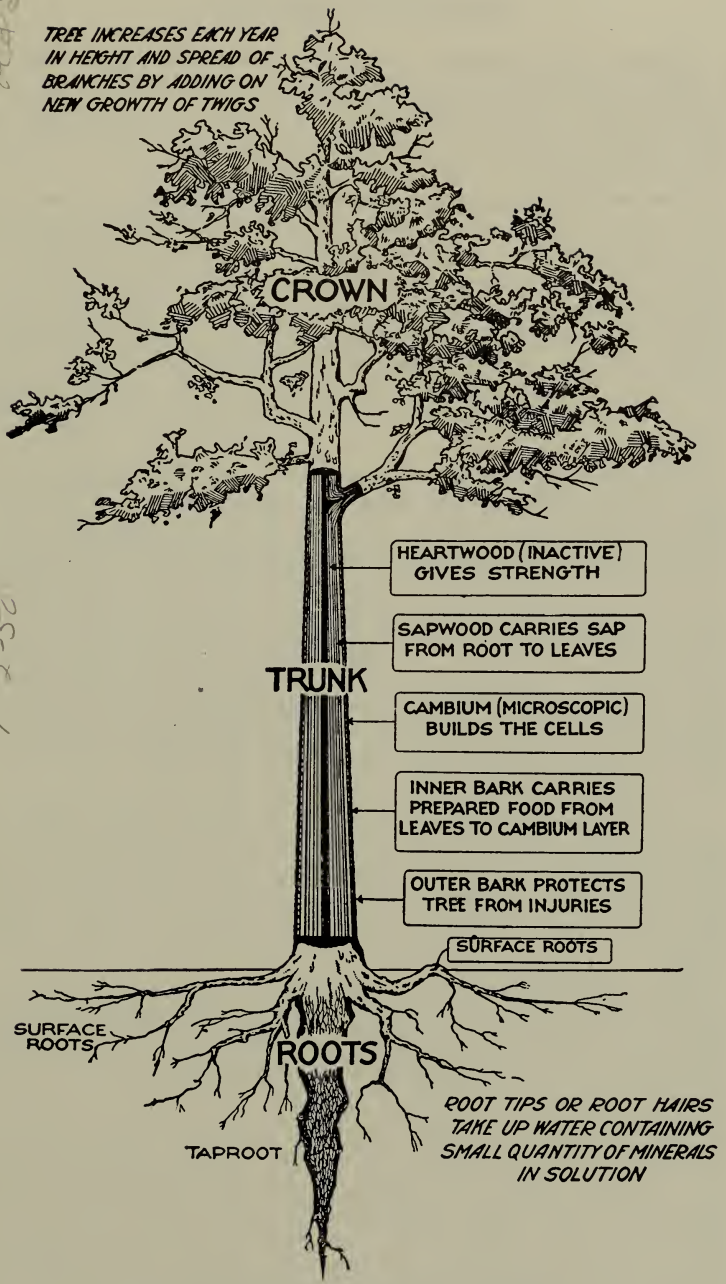
Until the upward growth has developed leaves, and the leaves have taken on green color, the young plant depends on the mother seed for food. This explains why the seed contains so much starchy material. But as soon as green leaves are formed the mother seed is discarded, for then the seedling is able to manufacture its own food.

Green pigment in the leaves, known as chlorophyl, plays a very important and interesting role. With water brought up from the soil through the roots and with carbon dioxide gas taken from the air through tiny leaf openings called stomata, tiny leaf laboratories energized by the sun's rays, produce grains of starch. Then by other laboratory processes the starch is converted to liquid sugar, an important part of the plant's food and an ingredient of sap.

Sap is a combination of plant food elements, the chief of which is liquid sugar but, while less in quantity, yet none the less essential, are the plant food materials coming up from the soil. The food of the tree contains the same elements as the food of man.

After the necessary elements of soil and air are assembled in the leaf, the liquid plant food or sap produced, is transported by the inner bark to supply the growth demands of the tree.

What makes soil water move up the tree to the leaves? It is not certain that this question has ever been fully answered. The water entering the roots contains dissolved minerals, and climbs against the force of gravity all the way to the top of the tallest tree. A more wonderful thing is not to be found in all the realm of nature.



The tree must constantly take water from the soil, not only for its need of water, but for the plant food the water carries. To keep up this intake, the tree must get rid of water. This is done by the tree transpiring or evaporating of moisture into the air mainly through the leaves.

Plant physiologists have found that the main force at work in lifting sap up the tree and for carrying plant food throughout the tree is the power that seeks to equalize the strength of solutions in the cells—this is called osmosis. Consider for example, two tree cells side by side, one may have less water and therefore contain a stronger solution than the other. Osmosis begins. It is always operating to keep the contents of cells at the same strength of solution. Cell walls do not hinder its operations. Enough of one cell's contents is forced to soak through cell walls to equalize the strength of the contents of the other.

But fortunately osmosis never quite succeeds in its efforts. Transpiration or evaporation of water and the conversion of food into fiber keep the cells varying in the strength of their solutions, hence, a constant pull and movement of sap. Likewise, the elaborated plant food moves to various parts of the tree to meet growth requirements.

It has been thought that capillary action along with osmosis, may play a part in carrying sap up the main sap channels. This action is similar to that operating in a wick of an oil lamp where oil is carried up to the flame. The sun's rays are supposed to act similarly to the flame of a wick. Capillary action is also manifested in the movement of water upward in the soil to replace that evaporated from the surface, or taken away by roots.

Something of the magnitude of the force operating within the tree to transport water and plant food may be appreciated when it is realized that on hot days a large tree will take up as much as 150 to 300 gallons of water. The tree's pumping, and sap and plant food transfer system operate noiselessly, smoothly and never require repair.

The same elements of plant food used by agricultural crops are needed by trees. They too require a balanced ration, and though there may be an abundance of all plant food elements in the soil, except an essential one, like nitrogen, the tree's growth can be no greater than the short supply of this element will admit.

To understand more fully how trees grow, it is well to consider briefly their cellular structure. Like all other living things, trees are made of cells. These vary greatly in size and shape, but all living cells have walls enclosing loose granular material near the center of which is a small darker mass—and sometimes two—known as the nucleus. Certain cells have the power of creating other cells which accounts for growth that increases the diameters of tree trunk and limbs and the extension of twigs.

That mysterious growth power of the seed embryo is transmitted to a thin line of minute cells just under the tree's bark, known as the cambium layer. These little builders make bark on the outside, sap-wood on the inside, and young leaves, buds, flowers, fruit, roots—all in accord with the specifications of the kind of tree they are building, and with absolute efficiency. In a sense, osmosis is a mortar and brick carrier for the tree's mason—the cambium layer.

Taking a cross section of a tree trunk, on the surface we find the bark, or cork, made of strong walled cells. The outer bark performs no part in tree growth, but it does perform a very important part in protecting the tree from extreme temperatures, from injury by insects, and fungi of decay. It also reduces the severity of wounds of fire and accidental blows. The outer bark, therefore, serves as a tree overcoat and shield.

Beneath the corky outer bark is the inner bark. This serves to carry prepared food from the leaves to the cambium. Beneath the bark layers is the thin, vital cambium layer already mentioned. Because of its vital functions, it can be readily understood why in severing the cambium by girdling a tree with an axe, the tree immediately dies.

The next layer as we approach the center is sapwood, or new wood. Sap-wood cells are still active in tree growth, especially for transporting sap from roots to leaves.

Beneath the sap-wood is the heart wood. Heart wood cells were once sap cells, but have been retired and serve largely to give strength to the trunk. These cells add to the firmness of the wood and make a hard, strong core, helpful in resisting the force of storms.

In the center of the tree trunk are the pith cells—in some trees well defined, in others not. Radiating from the center and extending all the way to the outer bark are the flat ray cells which afford means of transferring materials to storage cells. All the characteristics of the tree trunk also belong to the limbs and twigs of the tree.

But down in the soil are tree roots that must receive important mention in naming the facilities employed for tree growth. Roots serve two purposes, one to anchor the tree to the ground; the other to absorb moisture and plant food materials from the soil. The chief means of absorbing these materials is provided by very small, hair-like roots, so small as to be almost invisible to the eye. These cling closely to soil particles and by the pull provided for sap movement are able to take in through their delicate cells moisture and materials which are immediately passed on up into the tree.

Buds for flowers and fruit are familiar to all, but there are other buds that one does not see because they are hidden from view. They are located in the bark or on roots and perform no part in tree growth unless in some emergency or change of environment the tree can use them to put out new growth. They are present on the roots

of some species of trees and produce sprouts or coppice. On others they are absent from roots, but are generally present in the bark. Sometimes a near-by tree is removed, letting in sunlight and providing space for tree expansion. The latent buds in the bark come to life and make use of this opportunity for new growth.

Trees breathe as do animals, but they have no lungs for the purpose. Oxygen from the air is taken into the tree through the little leaf openings called stomata, already described as taking in carbon dioxide. Oxygen is also taken in through openings in the bark called lenticels. Both the leaf and bark openings expire carbon dioxide, just as animals breathe out carbon dioxide but only through one opening—the nose.

The age of a tree can be determined by counting the rings of its trunk when it has been felled, or by counting the rings on a core removed from a tree trunk by an increment borer. Each ring represents a year's growth. The light part of the ring is the growth made in the Spring, and the dark part that is made in the summer. But in some species of trees the rings are uniform in color, and the annual growth cannot be distinguished clearly without a magnifying glass. The Spring growth is soft and porous to facilitate rapid transfer of sap for tree growth. The denser summer growth adds strength to the wood.

Having learned something about how the trees grow, the next step will be to learn how to identify trees.

HOW TO KNOW TREES

About 165 species of trees are found in Georgia, not to mention numerous species of shrubs. How many trees do you know? Everyone should want to know something about trees not only for the satisfaction of knowing, but because a knowledge of trees can be useful.

In starting out to learn trees, it may be well to know that a tree differs from a shrub in that a tree has a single stem or trunk which increases in size from year to year and its limbs are developed on this stem, whereas shrubs have no single stem but begin branching underground or near the surface.

Trees are classified into groups or families because of their general characteristics such as cone bearers, or pod bearers, or needle leafed, or broad leafed.

These families include trees with distinct differences which lead to a classification called species. For instance, the pine family in Georgia has ten species, the longleaf, slash, loblolly, short leaf, Virginia, spruce, white, pond, pitch, and table mountain pines.

In classifying trees, consideration is generally given to differences in leaves, bud, flower, wood, fruit, bark, and branching habits, but most trees can be identified by their leaves and fruit, so that this discussion will be confined to these two characteristics.

The most noticeable difference in tree foliage is that some trees have evergreen leaves, while others lose their green color in the Autumn, drop them and grow new ones in the Spring. The trees that lose their leaves in the Fall are called deciduous.

Usually the trees with needle-like leaves—like the pines—are true evergreens, and trees having broad leaves are deciduous. But some broad leaves like the holly, magnolia, and liveoak, have acquired the habit of keeping their foliage green and holding it more than a year. Another exception is the cypress which bears cones, but sheds its foliage annually.

Which kind of tree, an evergreen or a deciduous, do you think has an advantage? The evergreen, needle-leafed tree was the first to appear on the earth as shown by fossil remains. Its descendants, the pines, are most widely spread and abundant of all trees in the world today. This would indicate that evergreen needle leaves are, at least, not a serious handicap.

The open structure afforded by the needle leaves is some protection against an over-burden of snow, and the force of the wind is lessened thereby.

Another advantage in being evergreen is that chlorophyl is present to produce plant food earlier in the spring and later in the fall than is possible with deciduous trees.

While needle-leaf pines allow more sunlight to reach seedlings on the ground, the broad leaf trees make up for their dense shade by having their young growth equipped with shade leaves which are larger than even those of the large parent tree. The broad-leaf seedlings are therefore more tolerant of shade than the pine seedlings. Broad leaves make good use of this advantage. Under the pines where there is more sunlight the hardwood seedlings sometimes come up and smother out the pine seedlings so that when some pine forests are cut, broad-leaf trees may take their place.

This is only one of many ways tree species contend with each other for possession of the land.

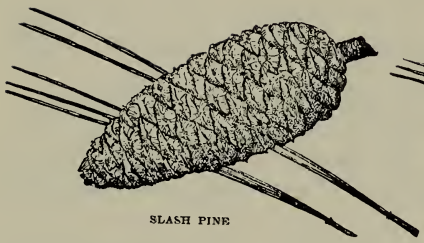
Everyone has noticed that different species of trees have leaves of different sizes, some being small like those of the pines, and others large like those borne by the palm, catalpa, and mountain magnolia. All perform the same functions apparently equally well, and the differences are perhaps due to Nature's tendency to follow an urge toward variations in an experimental effort to produce something better.

Aside from leaves and fruit to be discussed, an interesting way of identifying some trees is by their odor and taste. The cedar and pine have their distinctive odors; the leaf of the sourwood is very sour to the taste; the bark of black birch has the familiar taste of the wintergreen in chewing gum; the slippery elm's inner bark is a slick pulp; black walnut hull tastes and stains like iodine; freshly cut red oak has a strong acrid odor; sassafras wood has a distinctive and pleasant odor; cherry bark has a bitter taste.

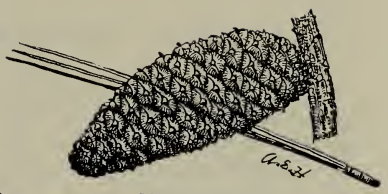
In trade channels especially, the word "Southern Yellow Pine" is used. This applies to all Georgia pines except the White Pine, and more particularly refers to the wood of older trees with their denser, harder wood than that of second growth.

"Naval Stores Pines" are the Slash Pine and Longleaf Pine. Gum obtained by chipping these trees is distilled to produce rosin and spirits of turpentine, both of which constitute naval stores.

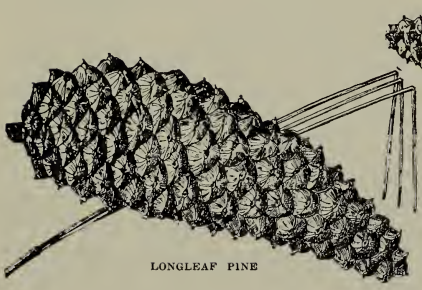
Only some of the general characteristics of species of the more useful trees are given in the following discussions. For complete details of tree species "*Common Forest Trees of Georgia*" is recommended for non-technical descriptions.



SLASH PINE



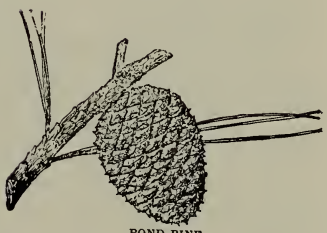
LOBLOLLY PINE
LOBLOLLY PINE



LONGLEAF PINE

SHORTLEAF PINE

SCRUB PINE



POND PINE

WHITE PINE

CYPRESS

DISTRIBUTION OF TREE SPECIES OF GEORGIA

With Description of the Most Useful Species

TREES FOUND MAINLY IN THE COASTAL PLAIN

SLASH PINE (*Pinus caribaea*). Important commercial tree with needle leaves 8 to 12 inches long, in clusters of 2 and 3; cones greyish brown 3 to 6 inches long; wood used for saw timber, poles, pulpwood; tree produces naval stores.

LONGLEAF PINE (*Pinus palustris*). Important commercial tree; leaves 10 to 18 inches long in clusters of three—the longest of any pine; cones dull brown, 6 to 10 inches long; wood valued as saw timber, poles, cross-ties; tree produces naval stores.

Two other pines of little importance are POND PINE (*Pinus serotina*), found in ponds and poorly drained areas, and SPRUCE PINE (*Pinus glabra*), found in swamps bordering rivers and streams.

BALD CYPRESS (*Taxodium distichum*). Grows in swamp lands; its leaves are feather-like, attached to branchlets that shed in the fall. Cones are about 1 inch in diameter and round with irregular surface. The wood is light and one of the most durable of all woods when exposed to the weather. This tree makes excellent poles.

TUPELO GUM (*Nyssa aquatica*). Found in river swamps; leaves oblong, pointed, 5 to 7 inches long; fruit oval, about 1 inch long; wood used for veneer in making small boxes, baskets, crates, and for making paper pulp.

SWEET BAY (*Magnolia virginiana*). An evergreen found in shallow swamps and rich hummocks; used for handles, woodenware; leaves oblong, bright green above, whitish beneath, 4 to 6 inches long, 1½ to 3 inches wide; dark-red conical fruit 2 inches long, 1 inch thick.

MAGNOLIA (*Magnolia grandiflora*). An evergreen of the forests; leaves oblong—ovate pointed, 5 to 8 inches long and 1½ to 2½ inches wide. The tree's chief use is for ornamental plantings.

The Oaks found only in south Georgia are LIVE OAK (*Quercus virginiana*), evergreen, well known as a shade tree; TURKEY OAK (*Quercus catesbaei*), a scrub of no commercial importance; LAUREL OAK (*Quercus laurifolia*). SWAMP CHESTNUT OAK (*Quercus prinus*), valuable, but scarce; OVERCUP OAK (*Quercus lyrata*), a valuable tree but not abundant enough to be commercially important; used as white oak timber.

TREES FOUND MAINLY IN PIEDMONT AND MOUNTAINS OF GEORGIA

WHITE PINE (*Pinus strobus*). Native of the mountains; needle leaves bluish green, 3 to 5 inches long, in clusters of 5; branches in whorls; cones slender, 4 to 8 inches long; wood light, easily worked and favored for boxes, shingles, laths, matches, and paper pulp.

HEMLOCK (*Tsuga canadensis*). Native to mountains; leaves spread to give a flat, feathery appearance, ⅓ to ⅔ inch long and

WHITE OAK

POST OAK

WATER OAK

CHESTNUT OAK

SWAMP CHESTNUT OAK

SOUTHERN RED OAK

BLACK OAK

SCARLET OAK

NORTHERN RED OAK

BLACK JACK OAK

LIVE OAK

OVERCUP OAK

1/16 inch wide; cones ½ to ¾ inch long, with broad scales; wood rough and brittle, used for rough lumber and bark for tannic acid.

VIRGINIA PINE (*Pinus virginiana*), is a mountain and upper Piedmont species, used for rough lumber and pulpwood and is known also as Scrub Pine. Its twisted needles appear 2 in a cluster, 1½ to 3 inches long; cone about 2 inches long; branches are persistent, making knotty lumber.

PITCH PINE (*Pinus rigida*) and TABLE MOUNTAIN PINE (*Pinus pungens*) are found sparsely in the upper part of the state but are not of commercial importance.

BLACK LOCUST (*Robinia pseudacacia*) attains greatest size in the mountains but is found throughout the northern half of the State; especially valued for fence posts and poles because of durability of the wood; leaves compound, feather-like with 7 to 19 thin leaflets; grows best in moist, rich soils.

BLACK WALNUT (*Juglans nigra*). Native to the northern half of the state; leaves are compound with 15 to 23 leaflets; nut oval 1⅛ to 1½ inches in diameter; valued for its nuts and hard, dark brown wood for furniture and furnishings.

BLACK CHERRY (*Prunus serotina*). Valued for its hard, beautiful, light brown wood; leaves oblong, pointed, finely toothed, 2 to 6 inches long and 1 to 1½ inches wide; fruit dark red berry ⅓ to ½ inch in diameter; bark bitter and used in medicine.

CHESTNUT (*Castanea dentata*) now almost obliterated by blight, but wood of dead trees is useful for producing tannic acid, pulpwood, lumber, poles and cross-ties. Leaves oblong, pointed at apex, coarsely notched margins, 6 to 8 inches long and about 2 inches wide. Nuts enclosed in prickly burs.

CHESTNUT OAK (*Quercus montana*) in the mountains and Piedmont has a valuable wood used much like that of the white oak. Leaves resemble that of the chestnut in shape, but margins are lightly scalloped rather than toothed and rounder at tips, and are 5 to 9 inches long.

Other trees confined to the upper part of the state but not of commercial importance, are BUTTERNUT (*Juglans cinera*), found in the mountains; BLACK BIRCH (*Betula lenta*), its bark used for wintergreen flavoring; MOUNTAIN MAGNOLIA (*Magnolia fraseri*), long leaves not evergreen; CUCUMBER TREE (*Magnolia acuminata*); BASSWOOD (*Tilia species*); CHINQUAPIN (*Castanea pumila*); IRONWOOD or HOP HORNBEAM (*Ostrya virginiana*); BOX ELDER (*Acer negundo*); BUCKEYE (*Aesculus octandra*); WHITE ASH (*Fraxinus americana*); SILVERBELL (*Halesia carolina*); SLIPPERY ELM (*Ulmus fulva*).

TREES FOUND IN ALL PARTS OF GEORGIA

LOBLOLLY PINE (*Pinus taeda*), useful, rapidly grown tree in all parts of the state, except higher altitudes of the mountains, but most

PIGNUT HICKORY

WHITE HICKORY

BITTERNUT HICKORY

SCALY BARK HICKORY

BLACK WALNUT

PECAN

abundant in the Piedmont. Valued for lumber; leaves are 6 to 9 inches long, 3 needles to a cluster; cones 3 to 5 inches long and distinctly grey in color.

SHORTLEAF PINE (*Pinus echinata*), most widely distributed of any pine in the state, but most abundant in Piedmont; valued for its lumber. Leaves are 3 to 5 inches long, in clusters of 2 and 3, dark blue-green; cones are 1½ to 2½ inches long.

RED CEDAR (*Juniperus virginiana*). Its wood is aromatic and reddish, favored for fence posts, poles, chests and interior finish. Leaves are about $\frac{1}{16}$-inch long, dark blue-green; fruit is berry-like, ¼ to ⅓-inch in diameter dark blue when mature.

YELLOW POPLAR (*Liriodendron tulipifera*). Rapidly growing tree reaching great size on rich, moist soils; leaves stubby, 5 to 6 inches long and wide; cone shaped fruit; wood yellow. Wood valuable for lumber and mill work for building purposes.

RED or SWEET GUM (*Liquidambar styraciflua*). A tree valued for its reddish brown wood used exclusively for furniture and furnishings; leaves star-shaped; fruit round, about an inch in diameter with seed enclosed in capsules.

HICKORIES—Four hickories are found throughout the state: BITTERNUT (*Carya cordiformis*) with reddish wood and leaves smaller and slenderer than other hickories; SCALY-BARK or SHELL-BARK (*Carya ovata*), so named from its bark; usually has five leaflets; WHITE HICKORY (*Carya alba*), tall, short limbed tree, leaves strongly scented and larger than those of other hickories; PIGNUT HICKORY (*Carya glabra*), tree with narrow, oval crown; fruit usually pear-shaped.

The PECAN (*Carya pecan*) has been extensively introduced into the state for its nut.

Hickory wood is used for handles, vehicle parts, and wherever tough, elastic wood is needed.

OAKS—WHITE OAK (*Quercus alba*) is one of the most useful of the oak species and is used extensively for furniture, interior furnishings, and tight cooperage. Leaves deeply indented, finger-like lobes, 5 to 9 inches long, 2 to 4 inches wide; bark light grey.

POST OAK (*Quercus stellata*), slow growing, grey bark, dark brown wood used for the same purpose as White Oak; leaves usually have 5 rounded lobes with cross-like shape.

RED or SPANISH OAK (*Quercus rubra*), useful for rough lumber. Leaves have long lobes at tips; some leaves slender with 4 or more lobes, others 3 lobed with rounded tip; wood light red from which it gets its name.

Other Oaks of little commercial importance are WATER OAK (*Quercus nigra*), favored as a shade tree; SCARLET OAK (*Quercus coccinea*), named from the color of its leaves in the fall; BLACK JACK OAK (*Quercus marilandica*), with leaf bulging at its end; WILLOW OAK (*Quercus phellos*), willow-like leaf; BLACK OAK

(*Quercus velutina*), with yellow inner bark; NORTHERN RED (*Quercus borealis*), similar to Spanish Oak, with broader leaves and more lobes.

MAPLES—RED MAPLE (*Acer rubrum*) is the most common and useful of the maples, and is manufactured into furniture and woodenware. Its leaves are typically three-pointed, 2 to 5 inches long; fruit ripens in late spring or early summer. SILVER MAPLE (*Acer saccharinum*), named from silvery grey under surface of leaves, used to some extent for shade trees.

ELMS—AMERICAN ELM (*Ulmus americana*). Its tough wood is used for hubs of wheels, saddle trees, barrel hoops, and for veneer purposes. Leaves are 4 to 6 inches long, lop-sided. WINGED ELM (*Ulmus alata*), sparsely scattered, corky growth or "wings" on smaller branches.

WHITE ASH (*Fraxinus americana*), most abundant in the northern half of the state; useful because of its toughness and elasticity for handles and athletic goods; found along streams and in mountain coves. Leaves opposite, compound with 5 or more leaflets; seed have single, oar-shaped wings.

BLACK GUM (*Nyssa sylvatica*), prefers moist soils, abundant in swamps, used for pulpwood, veneer products, crates; wood white; leaves oblong; berry fruit.

Other species of trees scattered widely but of little or no commercial importance in Georgia are:

BLACK WILLOW (*Salix nigra*), along streams.

RIVER BIRCH (*Betula nigra*), bark that peels and curls.

HACKBERRY (*Celtis occidentalis*), rough surface, berry fruit.

HORNBEAM or IRONWOOD (*Carpinus caroliniana*), hard, tough wood.

BEECH (*Fagus grandiflora*), light grey bark; 3-sided nut.

MULBERRY (*Morus rubra*), fruit like a blackberry.

SYCAMORE (*Platinus occidentalis*), limbs white, fruit in balls.

DOGWOOD (*Cornus florida*), small tree, white flowers, red berries.

SASSAFRAS (*Sassafras officinale*), aromatic, durable wood, berry fruit.

HOLLY (*Ilex opaca*), evergreen, prickley leaves, red berries.

PERSIMMON (*Diospyros virginiana*), hard, useful wood, edible fruit.

SOURWOOD (*Oxydendron arboreum*), wood hard, leaves crimson in fall.

RED BUD or JUDAS TREE (*Cercis canadensis*), ornamental tree.

HAWTHORN (*Crateagus*), several species, thorny; berry fruit.

HONEY LOCUST (*Gledista trianthos*), tree of long leaves and twisted pods.

SERVICE-BERRY (*Amelanchier canadensis*), red edible berries.

HOW TO COLLECT AND CARE FOR TREE SEEDS

Before collecting tree seed a decision must be made as to kinds adapted to the site to be planted. If a hillside is to be planted, one would seek seed of trees known to grow on such a site. Then from a list of trees adapted to the hillside one will want the species that will give the greatest returns. Suppose pines are selected. Then the question arises as to what kind of pine. If after you study the pines you decide that for your region, the loblolly is best, you would then begin to think about where to get loblolly seed. Tree seed, like the seed of other plants, differ in their productive power, this power being largely determined by the parent tree. With this in mind, you will, therefore, look for a thrifty loblolly pine tree that has made rapid growth from which to obtain planting seed.

If walnuts were to be planted for raising nuts, seed would be taken from a heavily fruited tree, but since the loblolly pine is to be grown for its wood, the number of cones on the tree would not be a guide so much as rapid wood growth.

When to collect tree seed involves an important decision to assure good germination. If elms, maples, cottonwood, mulberry, and other tree seed are to be gathered, the harvest time will be in the Spring or Summer, but the fruit of most trees matures in the Fall, at which time seed begin to fall.

Not all tree seed can be successfully gathered from the ground. Winged seed fly away, hence the time to gather loblolly pine seed, which are equipped with wings, is before they have a chance to fly.

The seed of all pines in Georgia mature in the Fall and immediately the cones open and the seed are released. Therefore, the cones must be gathered in advance of their opening. Since the maturing time varies with weather conditions, no definite date for harvesting seed can be fixed, but the periods for gathering longleaf, loblolly, and shortleaf is roughly from the middle of September to October 20, and slash pine from September 1 to October 1, varying with the weather.

A better way to decide when to gather pine burs is to note when they begin to turn brown. The seed are mature enough before the cone has turned completely brown. In harvesting seed of yellow poplar, one should observe the first signs of cones beginning to open and gather them immediately.

An easy way to gather seed is to visit the tops of felled trees, being sure that the seed were mature when the trees were cut. In the absence of logging operations, the seed must be taken from standing trees. It is well to have shoe spikes and belt similar to those

used for climbing telephone and electric light poles. As an aid to dislodging the cones, use a long pole with a blade or hook at its end.

As soon as the cones are gathered, place them on a sheet or tarpaulin in the sun, or spread them out to a thickness of one cone on a dry floor. If placed in the sun, they must be moved to shelter before every rain. If there are indications of mold, turn the burs over and if convenient, start a fire in the storage room to dry out the burs.

After the burs are thoroughly dry, the seed can be shaken out. Rub off the wings and store the seed in closed containers for protection against mice and rats, then place them in a shady, cool place where they can remain until time for planting in the seed bed. If cold storage is available, the seed may be placed therein to good advantage; but in that case, the seed containers should be open and not closed.

Large seed, with hard shells like the acorn, walnut, and hickory, can be gathered from the ground, and if they are to be used for planting, steps must be taken to keep them from becoming dry to the extent of cracking and shriveling. But after drying a few days to remove excess moisture, the seed are placed in layers in the ground with dirt between layers and on the top.

They can be similarly treated in boxes containing sand and kept indoors, providing the sand is moistened lightly about once a week. Those in the open ground need not be watered.

NATURAL REPRODUCTION—SEED TREES AND THEIR OFFSPRING.

HOW TO GROW TREE SEEDLINGS FOR PLANTING

Most forest trees exist as the result of natural reproduction, that is, trees have sown their seed and produced their own seedlings. Since Nature has taken care of reforestation, the question may be asked, "Why bother about growing planting stock in seed beds?"

The answer is that when a forest is artificially established the exact species desired is obtained, and the trees are correctly spaced for best growth. Moreover, Nature can not be relied upon to produce tree seed every year. In some instances, years elapse between seed crops. But seedlings may be planted any year. Artificial reforestation is, therefore, more reliable and speedier than natural regeneration of young trees.

If the following directions are followed, good planting stock may be obtained.

SEED BED SITE: Select fertile, well-drained, loamy soil, preferably soil that has been under recent cultivation. Avoid fallow land where cut-worms are likely to be numerous; also avoid soil with Bermuda grass, Johnson grass, or nut grass.

Select a site, if possible, that will be shaded in the afternoon, but in obtaining such a site if the bed is located near trees, dig a trench about 18 inches deep to sever tree roots and thus prevent competition of trees with seedlings.

It is quite important that the seed bed be near a source of water, either branch or well, since frequent watering will be required.

Break the ground in the Fall and again shortly before the seed are to be planted. If the soil is not highly productive, it may be treated with well rotted barnyard manure, or cotton fertilizer. Either should be applied and worked into the ground at least two weeks before seed are planted to prevent injury to germination.

MAKING THE SEED BED: For convenience in weeding, thinning and watering, the seed bed should not be more than four feet wide, and, of course, as long as is necessary to accommodate the quantity of seed to be planted.

While not always necessary, a safeguard against burroughing moles and rats, may be provided by sinking a board 12 inches wide into the ground about 4 inches deep all around the bed. Another 12-inch board may be placed on top of the ground board to provide a base for stretching woven wire to exclude birds and fowls, and, when necessary, to serve as a base for a shade cover.

TIME TO PLANT SEED: Seed can be planted in the Fall or in February in south Georgia, but in north Georgia best results will be obtained by planting in February just before the growing season begins.

METHODS OF PLANTING: Seed may be broadcast on the bed or planted in drills. In drills it is easier to cultivate and weed the bed. Drills should be six inches apart and preferably extend across the bed rather than lengthwise.

It is recommended that about 30 seed be planted to the foot in the drill. Tree nurserymen seek to have 15 seedlings to the foot at the end of the season. If the percentage of germination is high, it will be necessary to do some thinning after the seedlings have become well established and promise to survive.

The planted seed should be covered very lightly—an eighth to a quarter inch. Good results have been obtained by "sanding," that is, by sprinkling a light cover of sand on the seed. Otherwise, use soil of the bed for covering.

SEED BED MULCH: Immediately after planting, cover the bed with pine straw. This mulch of straw should not be thicker than half an inch, else the soil will be kept cool and germination will be delayed. Burlap, coarse jute bagging used on cotton bales, or old fertilizer sacks, may be used as a cover in place of straw. After the seedlings have started growth, the cover should be removed.

SHADE: While experienced tree nurserymen have found that they can get along without shade, if seedlings show evidence of sun scald (browning), semi-shade may be provided until this trouble is corrected. The burlaps or sacks mentioned as a cover for the bed may be spread on supports so that they will be about two feet from the ground. Another method is to use wooden slats to give half shade, that is, place the slats as far apart as each is wide. Too much shade will cause a yellowing of the foliage, and if signs of this are observed, remove the shade cover.

WATERING: Bed should be watered thoroughly two or three times a week. A good shower of rain will take the place of one watering. The water should be sprayed on the bed. In most instances this calls for the use of a sprinkling can with a spray nozzle. Apply the water in early morning or late afternoon. Thoroughly moisten the bed, but do not saturate it to a point where it is water-logged or shows standing water several minutes after it is applied.

DISEASES: Should the seedlings begin to show signs of the damping-off disease, occurring two or three weeks after germination and evidenced by wilting, cease one or two waterings and scatter dry sand over the bed. A treatment of Semesan is also recommended, applying as recommended in instructions accompanying the material.

CULTIVATION: Shallow cultivation should be given not only to stir the surface of the soil, but to suppress grass and weeds. Cultivate every two weeks, or oftener if there is a heavy, packing rainfall. Hand work will be necessary to pull out grass and weeds that the cultivation does not reach. Of course, this should be done carefully so as not to disturb the seedlings more than is absolutely necessary.

HOW TO PLANT SEEDLINGS

With seedlings available in the seed bed, the next consideration is how and when to plant them. The seedlings grow in the bed through the Spring, Summer, and early Fall. It is during the winter rest period that the seedlings should be planted. They will then be ready to start growing with the coming of Spring.

WHEN TO PLANT: In south Georgia plantings can be made any time after the first frost. In the northern part of the State plantings will be safer if made in February. The reason for this difference in planting time is that in south Georgia freezes and thaws are not as severe as in north Georgia. Severe freezes and thaws disturb the roots of seedlings so much that they may not survive. It is better to plant after a rain. A dry period may result in poor survival.

SPACING: The next step is to determine the spacing or distance apart to plant the seedlings. In making this decision, the purpose for which trees are to be grown must be considered. If the primary purpose is to produce naval stores, the trees should be planted 10 to 12 feet apart. The object of planting so widely is to grow a bushy-top tree because this type of tree will produce the greatest amount of gum. But if trees are to be grown for lumber, poles, pulpwood, the purpose is to grow long trunks. This is attained by close spacing to create competition that will force upward growth of crowns to get exposure to sunlight. For this purpose plantings may be made 6, 7, or 8 feet apart.

PREPARING THE PLANTING SITE: Having determined the spacing to be given, the planting site may be prepared by plowing strips about 2 or 3 furrows wide, these strips being as far apart as the spacing to be given the trees. But suppose the planting is to be made on a hillside, would you run the furrows straight across the fill or on the contour, or level? If plowed straight, the furrows will start gullies before the seedlings are large enough to stop erosion. Therefore, plow and plant on contour.

On old fields where gullies and gald spots are found, plowing is impossible. Here the mattock will be needed for digging holes, and since the soil is poor, into these holes rich soil should be placed and perhaps fertilizers.

It is always well to allow the plowed soil time to settle before planting. Soon after a rain is an ideal time to plant.

LIFTING THE SEEDLINGS: In removing the seedlings from the nursery bed, special care should be taken not to disturb the root systems more than is possible. To this end, use a forked or tined spade. Insert deeply into the ground at the side of the row and lift the seedlings with as much soil with them as possible. Then carefully remove the soil so as not to break off the tiny roots. If some

soil is left attached it will be better. Do not pull the seedlings out of the soil, for this is certain to strip off some of the roots.

As soon as the seedlings are taken from the bed, place them in a bucket containing water, or better still, water mixed with clay. The purpose in using clay in the water is to give the roots a coating to hold the moisture in the plants that might be drawn out into dry soil to the detriment of the seedling.

PLANTING: Plant the seedlings as soon as possible after they have been taken from the bed. If not grown in a local seed bed but purchased from a nursery, and they arrive before preparations for planting have been made, heel the seedlings into the ground. As a rule it is better to break the bundles in which they have been shipped and heel the plants in separately. This will help to prevent heating and molding. Heeling in consists of putting the roots of seedlings in a shallow trench and covering them with soil, for the purpose of keeping the roots from drying out.

Make planting holes as deep as necessary to accommodate the full length of the roots. Should there be very long tap roots, they can be pruned back but not shorter than 6 or 8 inches.

Place the seedling as deeply in the ground as it was in the nursery bed. Put the richer surface soil in the bottom of the hole, press it firmly around the roots, fill in the hole and tramp firmly around the seedling. Airholes left in the soil will be harmful to the seedling.

In planting longleaf pine on deep, sandy soils, it is well to place pine straw around the seedling to prevent drifting sands from getting into the buds of the seedlings, for seedlings are sometimes killed by sand accumulating in the buds.

In spot planting to improve the stand in a forest, clear away competing vegetation for three feet around the planted seedling.

If the planting procedure described is carefully followed, a high percentage of seedlings will survive and a future forest will be given a good start.

PLANTING SEEDLINGS WITH A DIBBLE

HOW TO PROTECT FORESTS FROM FIRES

Fire is the tree's greatest enemy. Annually the forests of Georgia suffer fire damage to the extent of many thousands of dollars. Much of this damage could have been prevented, because most of the fires are man-made, and since they are man-made, they could have been prevented.

Some people burn the woods purposely. Why?

In south Georgia where cattle graze forest lands, burning is practiced to "green up" the grass in the Spring. The cattle men are thinking of fresh, green grass, and, of course, are not interested in allowing the lands to grow trees.

Turpentine operators burn off the forests they are working, first raking litter from around the trees. The purpose is to protect their cups and the "faces" of trees producing gum, from fire. Heavy losses might occur if some method of fire protection were not used.

Here again the woods burner is thinking of only one product—gum. He is not thinking of a future crop of trees when he lets his fire kill tree seedlings, nor is he using good judgment when he spends 25¢ to 40¢ an acre raking around the trees when, by the use of firebreaks and modern methods of fire fighting, he can protect the trees being turpentined at a cost of only 4¢ or 5¢ an acre. If he employed the cheaper and better method, he could have the satisfaction of knowing that he has left seedlings and young trees that in time he can turpentine in the same forest.

Others purposely burn the forests to kill cotton boll weevils. While boll weevils do winter over in the edges of woods adjoining infested fields, authorities on the boll weevil say that the early destruction of cotton stalks leaves no reason for trying to destroy boll weevils in their winter quarters.

If one is bent on burning to kill hibernating weevils, he should know that very few weevils enter the woods beyond 150 feet from the field. If he will go to the trouble of cutting grass, raking it and the forest litter into piles along the forest edge and then burn so as to destroy few seedlings; if he controls the fire so it will not scar the trunks and burn foliage of larger trees; and if he will not let the fire spread into the forest, the least damage will be done to the trees. But the early destruction of cotton stalks is a surer and safer way to dispose of the weevils.

Other fires are started purposely by hunters to drive game out of swamps or briar patches.

A great many fires are not started purposely, but thoughtlessly, as in the case of hunters throwing down burning matches and lighted butts of cigars and cigarettes in grass and leaves. Smokers should learn to grind into the soil with their heel any burning matches and cigarette or cigar stub discarded when in the fields or woods.

A great many fires get loose in the woods when farmers burn off their fields in late winter or early spring. Such burning is harmful to the soil in that the soil may erode; but if the farmer persists in the practice, he should first plow a firebreak around the field he is to burn.

Campers, hunters, and workers in the woods or along the highways who make warming fires, start forest fires which could have been prevented, if when leaving, they had extinguished the embers with water or covered them with earth. Some fires are started by sparks from railroad engines, also by riders in automobiles who toss cigar and cigarette stubs into grass along the highways. One rare source of fire in Georgia for which man is not responsible is lightning.

The chief reason for forest fires and for the indifference about fighting them when they are started, is the ignorance of people about the damage that is done. If everyone who does realize the extent of the damage, would undertake to educate those around him about it, the practice of burning off woods would be stopped.

People must be taught that:

1. Fires destroy countless millions of tree seedlings.
2. Fires destroy young trees or saplings.
3. Severe fires may kill mature trees or, by scorching off the leaves, greatly reduce their growth rate.
4. Fires make scars on tree trunks where organisms of decay, and insects may enter.
5. Severe fires may destroy many wild animals.
6. Fires destroy leaves and litter in the forest, rendering the soil hard and less penetrable to rain water and thereby:
   (a) Lessen the supply of soil moisture, thus endangering maximum tree growth.
   (b) Reduce the water of percolation for springs and wells.
   (c) Increase soil erosion by greater surface run-off.
   (d) Cause more silt, sand and gravel to enter reservoirs and stream beds.
   (e) Increase rapidity of surface run-off to cause greater floods and flood damage.

FOREST FIRE CONTROL: As a rule, forest fire prevention and control can be accomplished best by co-operation of timberland owners. In this way, more men are available to fight fire which, of course, means quicker suppression and the least damage.

Provisions have been made in Georgia for timberland owners to form Timber Protective Organizations, whereby they co-operate in the expense of fire-fighting equipment, such as erecting fire towers, telephone lines, trucks equipped with fire-fighting facilities, and even with a broadcasting station and radio equipment for woodmen's trucks. The better equipment, of course, is possible where the organized units control thousands of acres.

In a section of numerous farms with scattered forests, the Timber Protective Organizations are not easily formed, so that a county forest ranger is often more practical. The forest ranger can organize community groups to co-operate in fighting fires and can carry on an educational program to teach farmers the importance of forest fire protection.

FIREBREAKS: In large timber tracts, two kinds of firebreaks are constructed—primary and secondary. Primary breaks are at least 20 feet wide. They serve not only as breaks in the forest to stop fires, but as truck trails over which trucks can be rushed to reach fires. These breaks may be two miles apart. The secondary breaks are about 10 feet wide and generally run at right angles to the primary trails, at shorter intervals than primary breaks. The secondary trails are not wide enough to stop a raging fire, but they serve an important purpose as bases for back firing. A back fire is started so as to burn toward an approaching woods fire—which means against the wind—to form, or widen a firebreak across which the uncontrolled fire can not leap.

On large areas operated by Timber Protective Organizations, fire towers about 100 feet high are erected and manned by lookouts. A telephone system centers at the tower, and as soon as smoke is seen in the woods, perhaps five miles away, the lookout locates the fire and telephones to various co-operators, so that in a few minutes crews of men are on their way to fight the fire.

In areas where woodlands are scattered and do not occur in large tracts, firebreaks about 8 feet wide plowed at the edge of fields, will serve the purpose. If a farm forest is large, firebreaks may be made through the forest by raking six-foot strips free of combustible matter. A road-way or stream, of course, may be considered as a firebreak.

To be effective, firebreaks must be free of combustible matter, hence they must be plowed or cleared of dead vegetation once a year, else they will be a fire menace rather than a firebreak. Fires may be fought with portable water-spray outfits or rubber flaps equipped with handles, or with well leafed pine limbs.

To make sure that the wind does not scatter the embers of smoldering fires to start new blazes, it is well to keep guard until all fire is out. In the pine belt, dead trees or snags may burn to considerable heighth from which winds can scatter embers for quite a distance. For this reason snags should be removed along firebreaks, and where they are not, they must be watched carefully during a fire.

HOW FORESTS ARE MANAGED

To get the largest farm crops several things are required, and to get the largest tree crops certain practices should be followed. It is quite as necessary for instance, to thin the forest, as it is to thin corn and cotton. When trees are too thick, the soil nutrients are not abundant enough to supply all the trees with maximum growth material and therefore no tree can make its most rapid developments.

A thicket of trees left unthinned will struggle along until some trees get an advantage and succeed in killing out others. If the thicket were thinned properly, much of the growth material wasted on the trees that were crowded and killed, would have gone into fewer trees with the result that merchantable timber would have been produced in shorter time.

A forest that has been allowed to grow up unthinned will have four classes of trees, the dominant, the codominant, intermediate and suppressed. The dominant stands highest, the co-dominant next, the intermediate still lower, and the suppressed the lowest and overshadowed by the others.

In thinning, the dominant trees, as a rule are to be left, but if a dominant tree is crooked, then it should be discarded in favor of a good co-dominant or intermediate tree.

Only general rules for spacing can be given. Good judgment is better than any rule, for every situation involves its own problem.

The general purpose is to give trees a spacing that will enable them to make the best commercial growth, but if two thrifty trees are close together and nearing, say a pole size, then they should be allowed further growth before removing one for a pole.

The question arises as to when to make the first thinning. The time to make the first thinning is when it is apparent that the diameter growth of the trees has slowed down materially. The reason for allowing them to remain thick, is to provide shade sufficient to cause lower limbs to die. The fewer the limbs, the fewer the knots and the better the lumber produced. The spacing should be just wide enough so that the crowns will fairly well cover the ground, leaving little room for crown expansion because the purpose is still to force upward growth rather than expansion of crowns. But if naval stores are desired, more crown space should be allowed. This, of course, means fewer trees per acre.

In many instances, the forest will require more than one thinning. When thinned at 25 to 35 feet in height, the crowns will close up in a few years and growth will again be retarded, so that another thinning will be advisable. The trees will then have attained greater commercial value for naval stores, or poles, or pulpwood.

The same general principle should be applied at the second thinning, that is, to release the better trees from competition. Undesired species, crooked and diseased trees should be removed.

While no specific spacing can be given that will apply in all cases, it may be stated that when the trees are 25 to 35 feet high and are not growing thriftily, they should be thinned 10 to 12 feet apart. A good rule to use in obtaining the approximate spacing is: Add 4 to the number of inches in diameter and express the answer in feet. Thus if a tree is 7 inches in diameter, 7 plus 4 equals 11, and the tree should be no closer than 11 feet from another tree 7 inches in diameter.

When thinnings have been made, the saplings or trees cut down should be used for fuel or pulpwood. The tops should be cut up to place the limbs flat on the ground so as to reduce the fire hazard; but if there is considerable fire hazard, it may be well to gather the tops in piles and burn them, being careful that the fire does not get out of hand.

Pruning can be practiced to advantage where trees are scattered and are developing limbs near the base, and also to remove dead limbs among properly spaced trees. If limbs are growing on the lower part of the trunk, enough should be removed to at least produce one log that is free of knots. The object in cutting off dead limbs or snags is to allow the scars to heal up and grow over as soon as possible.

When trees are grown for naval stores, and large crowns are desired, it is also desirable that pruning be practiced to rid the trunks of knots that always prove a hindrance to chipping and reduce gum production.

Pruning of small trees is unwise inasmuch as growth may be affected. In general, trees should be at least 12 feet tall before the lower limbs are pruned.

TYPICAL FOREST SHOWING DOMINANT (1), CO-DOMINANT (2), INTERMEDIATE (3) AND SUPPRESSED (4).

HOW GEORGIA'S WOODS ARE USED

Georgia's great variety of trees find many uses. The qualities of wood that determine its use are hardness, strength, flexibility, toughness, color, arrangement of wood cells, odor and other characteristics.

The farmer needing fence posts wants wood that is durable in contact with the soil. Black locust, cedar, heart pine, sassafras and white oak are best suited for the purpose.

Furniture makers want chiefly wood with strength, hardness, wood that will not warp or shrink, with beauty of grain and capable of taking a high polish. These qualities are found in walnut, oak, cherry, mahogany and gum. For less expensive furniture they will accept softer woods such as yellow poplar, pine and maple.

Wagon makers or manufacturers of tool handles and athletic goods use tough, hard, flexible wood such as is provided by ash and second growth hickory.

Telephone, telegraph, power, and railroad companies want poles of strong or elastic wood of trees that grow tall, with slight taper, that are durable in contact with the soil. Such requirements are met by cypress, cedar, chestnut, and pine when creosoted.

For cross ties, railroads want close grained wood capable of holding spikes under stress, such as oak, cypress, hickory, gum and pine.

Manufacturers of textile mill supplies desire for bobbins, shuttles, and spools, wood that is dense, very hard and will stand great stress without splitting or wearing, such as dogwood, persimmon, and ironwood.

The veneer manufacturer who serves the furniture and interior finishing trade, seeks beautifully grained wood that is also hard and capable of high polish, such as sweet gum, white oak, cherry, walnut, cedar and mahogany. For baskets, light boxes, and crates, the veneer manufacturer accepts black gum, tupelo gum, yellow poplar, Carolina poplar and other of the softer woods.

For turnery such as woodenware, porch columns, stairways, etc., soft woods such as yellow poplar, sycamore, buckeye, bass wood, tupelo, beech and birch are preferred.

Tight cooperage calls for strong wood with water-tight cellular structure. For this type of barrel the white oak is in greatest demand. For barrels not required to hold liquid, but are used for vegetables, bum, etc., the pine is most generally used in Georgia.

The paper manufacturer is using all species of southern pines but in addition, manufacturers of white paper are finding that the wood of black gum, tupelo gum, and the poplars when mixed with pine fiber, are very acceptable.

Georgia produces more than half the naval stores of the country, using for this purpose the gum of the slash and longleaf pines grow-

ing in the southern part of the State. In increasing numbers the owners of slash and longleaf forests are learning to chip their trees, produce gum, and market it instead of depending, as in the past, on leasing turpentine rights to turpentine operators. In this way the timberland owner gets larger profits. It is well for any future farmer of south Georgia to learn how to produce and market gum. A more detailed discussion appears in the next chapter dealing with harvesting and marketing.

The value of the leading primary products of Georgia forests in 1936 are as follows:

Lumber	$17,449,000.00
Fuel wood	7,050,000.00
Planing mill products	2,082,775.00
Veneer bolts	1,046,480.00
Naval stores	14,000,000.00
Boxes and crates	2,547,377.00
Cooperage	702,000.00

The 1938 demand on Georgia forests for pulpwood to be used by paper mills in this and neighboring states, is estimated at 820,000 cords.

Paper manufacture is only one of the products to which the cells of trees is converted. Industrial chemists are learning more and more about cellulose. Already wood cellulose is being used for the manufacture of transparent tissues known as "celophane" and "glassine," extensively used as wrapping material.

Cellulose is used for making artificial leather; artificial silk or rayon; photographic films and movie reels; explosives or T.N.T.; quick drying paint; lacquer, non-shatterable glass, etc. Progress is being made in the conversion of cells into palatable food. It has been said that we are at the threshold of the cellulose era, with many possibilities in store.

Wood flour is compressed and moulded into many forms, such as backs of hand mirrors, handles, cups, buckets, etc. Sawdust, bark and fibers of slab waste of saw mills are being steamed and converted under great pressure into wall board.

Plywood made of thin sheets of wood glued at cross grain to each other to form strong, thin sheets, is coming into greater and greater use.

It, therefore, appears that there is no end to the possibilities of the use of wood.

HOW TO ESTIMATE THE VOLUME OF TIMBER

Unless the timber owner knows the number of board feet he has in his forest, he is at a disadvantage when a buyer makes an offer. If the owner wants so many board feet of lumber to build a new barn, he should know how many trees to cut to get the amount needed. If he contracted to deliver to a mill or shipping point so many thousand board feet of logs, he should know how to fill the order correctly. He should also know how to fill orders for poles, cross-ties, veneer bolts, pulpwood, etc. All this calls for a knowledge of how to measure standing and cut timber.

DEFINITIONS: A *board foot* is a board one inch thick, one foot wide, and one foot long.

A *standard cord* of wood is a pile of wood 4 feet high, 4 feet wide, and 8 feet long.

A *long cord* or *unit* differs from a standard cord in that the sticks of wood are cut 5 feet long, making a cord 5 feet wide, 4 feet high and 8 feet long.

A *standard cross-tie* is 6 inches thick, 8 inches wide and 8 feet long from which some variations are allowed.

Poles may vary in length from 35 to 90 feet long, the greatest demand being for poles 40 to 55 feet long with minimum diameter of 6 inches at the top.

Diameter measurement — The diameter measurement of trunks of standing trees is made 4½ feet from the ground and is called D. B. H. measurement or Diameter Breast High.

Measuring Instruments To Be Used

An important measuring instrument is the caliper, which consists of a rule with inch marks, from which two arms project, one being stationary at one end of the rule, the other made to slide back and forth along the rule. With one arm at one side of the tree and with the sliding arm adjusted to the other side of the tree, the figure on the rule marked by the sliding arm gives the tree diameter or D. B. H.

Tree diameters can also be obtained with the gauged *Biltmore Stick*. Holding the stick in the middle and standing 25 inches from a tree, the stick is placed against the tree trunk 4½ feet from the ground, so that the left end of the stick will be in line of sight with the outer edge of the left side of the tree trunk. Then without moving the head, the eyes may be turned to observe where the line of vision crosses the rule on the right side of the tree. The figure on the rule at this point gives the diameter.

On the edge of the Biltmore stick are marks by which the number of logs in a tree can be determined. To do this, one stands 50 or 100 feet from the tree, places the rule in line with the tree trunk,

with its lower end of the rule in line with the 12 inches from the base of the tree. Then look up the trunk of the tree to a point where it tapers to about 5 inches. Where the line of vision at this point intersects the rule, one reads thereon the number of logs.

A *log scale stick* has the board feet computed on it for any diameter measured at the small end of the log.

All measuring sticks mentioned can be made by hand, but the Biltmore stick outfit costs only $1.00.

Extent of Surveys

If the volume of merchantable trees is to be determined on a small area, all such trees may be measured, but as a rule, sample plots or strips are surveyed and the volume of all the area is based on these sample plots. The samples, of course, should be typical of the whole.

Inexperienced timber cruisers should make estimates of at least 25 percent of the timber area. This can be done by measuring trees on strips 66 feet wide, (a chain) at distances of 264 feet apart.

A form on which to tabulate diameters and number of logs in each tree should be used. It should provide space for each species of tree and a place for recording half logs.

ESTIMATING CORDWOOD

In view of the growing demand of paper mills for pulpwood, it is important for the timberland owner to know what to cut for this purpose and how to estimate in cords the volume of standing timber to be sold, especially since pulpwood is quite generally bought on a stumpage or standing timber, basis.

WHAT TO CUT: Forest thinnings, crooked, diseased, and limby trees, undesirable species, when removed as forest improvement cuttings, make suitable pulpwood. The trees remaining can be used to produce higher priced products such as naval stores, lumber, poles, piling, etc.

As a general guide to cutting, the following rules are given:

Trees to Cut For Pulpwood	Trees to Leave in Cutting Pulpwood
1. Worked out naval stores trees.	1. Round longleaf and slash
2. Crooked and poorly formed trees.	2. Straight and best formed trees. pines.
3. Weaker crowned trees in dense stands and "wolf" trees overlapping young growth.	3. Trees with good thrifty crowns.
4. Over-mature, red heart trees.	4. Young, thrifty, fast growing pines.
5. Fire-scarred, insect damaged, or diseased trees.	5. Healthy trees free from injury.

How to Estimate Cords

Very few Landowners know how much pulpwood timber they have and are at a disadvantage in bargaining on a stumpage basis with timber buyers.

The amount of timber estimating will vary with the size of the tract of timber. On a 20-acre tract it may be 100 percent—that is, every tree may be tallied. On 20 to 40 acres, 25 percent; on 40 to 160 acres, 10 percent; on 160 to 640 acres, 5 percent; on 640 to 1,000 acres, 2½ percent. The total estimate can, of course, be obtained by multiplying the amount of cords on the sample strips by the number necessary to make 100 percent.

The strips or sample plots selected for cruising must be typical, which means that they should be selected at regular intervals regardless of the condition of the forest.

In estimating the volume of timber, take the diameter of a tree at 4½ feet from the ground (D. B. H.) and then estimate the usable length of the tree trunk, that is, from the ground to a point where it is 5 inches in diameter.

A tally sheet shown below is used in recording the measurements. Use the figure in the table nearest the estimated length. For instance, if your estimate is 31 feet, place it in the table under "32."

"TALLY SHEET"

	Usable length of stem in feet												
D.B.H.	12	16	20	24	28	32	36	40	44	48	52	56	60	64
6														
8														
10														
12														
14														
16														

Having recorded measurements on the tally sheet the next step is to determine the cubic feet of the tallied wood. Use the following table for this purpose:

CUBIC FOOT VOLUME TABLE, ROUGH WOOD

	Merchantable length of stem in feet													
D.B.H.	12	16	20	24	28	32	36	40	44	48	52	56	60	64
	Cubic foot volume (including the bark)													
6	1.6	2.2	2.7	3.2	3.6	4.3	4.8	5.4						
8		3.6	4.6	5.5	6.4	7.3	8.3	9.1	10.1					
10			6.8	8.2	9.5	10.8	12.3	13.6	14.9	16.3	17.7			
12				11.2	13.0	14.9	16.7	18.6	20.5	22.3	24.2	26.0	27.9	
14					16.8	19.3	21.7	24.0	26.5	28.9	31.3	33.7	36.1	38.5
16						23.8	26.9	29.8	32.8	35.8	38.8	41.7	44.7	47.7

The final step in determining the number of cords is to divide the total cubic feet by 90 for standard cords and by 113 for a long cord.

HOW TO HARVEST AND MARKET FOREST PRODUCTS

Harvesting forest products to the greatest advantage involves an active market and high prices. To be certain that the price is the best to be obtained, the timber owner should not be content with one bid. Nor should he be satisfied with one market, that is, if sawmills make a bid, he should see if in selling to some other line of manufacture, he can get more for his timber. By knowing the uses of the kind of wood he has, and the nearest markets, he can determine the best paying market for his timber.

The question of where to sell being answered, the next step is when, what and how to harvest.

The time to cut timber is in the Fall and Winter. At that time of the year the farmer is less active with his farm crops. The southern pine beetle is in hibernation then and is not attracted by the odor of fresh cut timber, to attack neighboring trees. When the "sap is down," of course, the wood is not full of moisture and it cracks or checks less as it dries out.

In answering the question of what to cut, it may be stated that as a rule the trees that are mature or nearly mature, should be harvested first, but if the market is for poles and most of the trees are pole size, then the wise thing to do is not to cut all the pole timber, but to practice thinning, so as to leave a good stand of trees to grow to saw log size, remembering that at that stage the trees are making their most valuable commercial growth at pole size.

If the demand is for pulpwood, the timber owner should undertake to fill the order with thinnings, leaving pole and saw log size timber for later cutting. One should also not overlook the opportunity of using the tops of saw timber and pole timber for pulpwood or fuel.

In determining what to cut, the timber owner should bear in mind that the greater number of different markets he is prepared to supply, the greater his returns are likely to be.

In the naval stores belt, the timber owner will find that it is decidedly to his advantage to sell thinnings as pulpwood, reserving well spaced trees to be turpentined later. After they are turpentined, he can use the trees as pulpwood or allow them to grow to pole or saw timber size, depending on which market promises to pay best.

An important matter to keep in mind is that trees should not be cut for pulpwood or for other purposes when they are making their most rapid commercial growth. For instance, a pine tree 5 inches in diameter, if allowed to grow to 6 inches in diameter, will produce twice as much pulpwood.

From this discussion it is evident that a timber owner has some real common sense thinking to do when determining what to cut for

the market. A general rule is: Cut so as to supply as many markets as possible; cut so as to keep the forest producing its maximum tree growth at all times, and cut so as to go to market with forest products as frequently as possible.

As to how to cut, the first caution is to avoid waste. Often one sees stumps 2 to 2½ feet high of perfectly sound timber. This waste is inexcusable. It is worth while to cut trees as close to the ground as possible, usually not higher than 12 inches.

The cross-cut saw for felling the tree and cutting the logs, gives less waste and greater returns than the axe used for this purpose.

Care should be taken in cutting a tree to have it fall so as to do the least possible damage to neighboring trees and to seedlings and saplings.

In removing logs from the forest, avoid bruising and skinning the trunk of other trees and breaking down saplings and seedlings. Snaking out logs to a wagon or truck can do a great deal of harm unless care is taken.

To be sure that the forest is well handled, it is better for the timber owner to cut his own trees, and not sell stumpage rights. If for any reason, it is necessary to sell stumpage, the timber owner should reserve the right to mark the timber to be removed and to supervise the cutting to see that his markings are respected.

Allow no tree less than 14 inches in diameter to be cut for saw timber. Nor should one allow any tree less than 10 inches in diameter to be turpentined.

Those concerned with naval stores production should follow the chipping recommendations of the U. S. Forest Service, which has conducted extensive experiments over a number of years.

In brief these recommendations are:

Leave at least one-third of the bark of a tree trunk unchipped to assure rapid healing of the tree.

Two faces should be used only on trees 14 inches and more in diameter.

Faces should be only 12 inches wide on trees 12 to 15 inches in diameter.

Streaks should not be made more than ½-inch in depth under the bark.

The width of each streak should not be more than ½-inch.

The timberland owner who does his own chipping can, of course, see that these and other regulations are carried out, and obtain greater returns, than when turpentining rights are sold to concerns interested only in getting all the gum they can with little regard for the future development of the forest.

TREE INSECTS AND DISEASES

Like most other living things, trees are afflicted with diseases and insects. Doubtless the most serious tree epidemic ever to strike this country is the Chestnut Blight. In some way this fungus was transmitted from abroad to America and once it became established it spread with great rapidity, killing all the native chestnut trees. The gaunt skeletons of this tree bear witness to this forest tragedy. Nothing could be done to check this deadly infection.

Another foreign invader in recent years is the Dutch Elm disease, now threatening the extinction of the elms of this country, but this disease is now being held in check by foresters and may eventually be eradicated. This tree disease has not reached Georgia.

White Pine Blister Rust is another destructive fungus attacking the White Pine and threatening to become epidemic. Since this species of pine grows in the mountains of north Georgia, preventive measures have been taken against its outbreak by destroying secondary host plants such as wild goose berries, currants, and raspberries on which the fungus must grow before it spreads among the White Pines. This work is directed by the State Bureau of Entomology in cooperation with federal agencies.

Many fungi attack forest trees, causing decay of tree trunks and twigs and defoliation, but under forest conditions no great harm is done and generally cost of control is prohibitive. One thing can be done to prevent tree trunk decay and that is keep fires out of the forest.

The most destructive forest insects in the South is the Southern Pine Beetle which attacks all species of pines. This insect is attracted by the odor of fresh cut wood, or exposure of inside wood by lightning. They may concentrate at such points in sufficient numbers to kill trees.

This insect lays eggs in the inner bark of the pine, so that when the grub hatches it can feed on the cambium layer. If enough grubs are present to girdle the trunk, of course, the life of the tree ends. From centers of infection the beetle may spread and kill a great many trees.

A preventive measure is to cut trees only in late Fall, Winter and early Spring; but if cut at other times, the tops and limbs should be removed or piled and burned.

When the foliage of a tree begins to turn yellow, and globules of gum appear on the trunk, the tree should be felled and the bark removed and burned.

Should a pine or other tree die in a forest, the sooner it is cut and utilized the better, for the reason the borer or "sawyer" beetle will soon riddle the tree with its borings. This borer does not attack live trees.

Occasionally grubs of saw flies are abundant enough to strip a pine tree of its needles, but exposed as they are to birds, their outbreak is soon controlled.

Another insect, known as the Tip Moth, deposits its eggs in tips of twigs. Its grubs burrow into the twig with fatal results to the twigs. As a result the tree's growth is slowed down. But this insect generally does no great damage.

A number of insects are friends of trees in that they carry pollen from flower to flower, and some lay eggs in the bark close to those of the Southern Pine Beetle's, so that their grubs can feed on the grubs of the destructive pine beetle.

Birds play an important part in insect control. Wood-peckers, especially, drill into the bark to get insect grubs. Other birds catch insects on the wing, feed on aphids attacking leaves and caterpillars foraging on foliage. If useful birds are slain, the forest suffers.